# NANOSCALE STRUCTURE OF POSITIVE ELECTRODES FOR Li-ION BATTERIES WITH CARBON-BASED ADDITIVES BY SANS

M. Yerdauletov[1,2,3], M.V. Avdeev[1,4], O.V. Tomchuk[1], O.I. Ivankov[1], Ph.S. Napolsky[4], V.A. Krivchenko[4]

[1]*Frank Laboratory of Neutron Physics, Joint Institute for Nuclear Research, Dubna, Moscow Region, Russia*
[2]*Institute of Nuclear Physics, Ministry of Energy of the Republic of Kazakhstan, Almaty, Kazakhstan*
[3]*L.N.Gumilev Eurasian National University, Astana, Kazakhstan*
[4]*Dubna State University, Dubna, Moscow Region, Russia*

E-mail: meyir2008@mail.ru

Energy storage technology based on lithium-ion electrochemical systems makes it possible to manufacture batteries with high specific energy and power densities. Over the past decades, such batteries have been the most widely used ones in applications related to electric vehicles, portable electronics, and robotics. Lithium-ion battery specific parameters can be significantly improved by reducing the mass contribution of inactive components, as well as by controlling the microstructure of the electrode layers. The present work is related to the development of scientific and technical tools for studying microstructure of a wide range of active cathode materials with carbon-based additives and improving their characteristics in respect with the specific energy of batteries.

Using the small-angle neutron scattering (SANS) method, the effect of conducting carbon additives (carbon black, carbon nanotubes, graphene and electrochemical graphen oxide) on the porous structure of positive electrodes based on lithium iron phosphate (LFP), lithium titanate (LTO), and lithium nickel manganese cobalt oxide (NMC) is studied. To separate the scattering by closed and open pores, the electrodes are wetted with deuterated electrolytes, which makes it possible to match the scattering by open pores. Conducting carbon additives are found to change the electrode porosity to different extent and affect the wettability of the materials, both due to the different effects on the degree of incorporation into the pores of the cathode matrix, and to the impact on the cathode matrix itself. The effect of the polymer binder (PVDF) is also revealed.

The structure analysis allowed us to improve and optimize the technology of the fabrication of high-capacity cathodes for lithium-ion batteries.

[1] M.V. Avdeev, M.S. Yerdauletov, O. I. Ivankov, et al., J. Surf. Investigation 13(4), 614 (2019).

[2] F.Napolskiy, M. Avdeev, M. Yerdauletov, et al., Energy Technology 8, 2000146 (2020).